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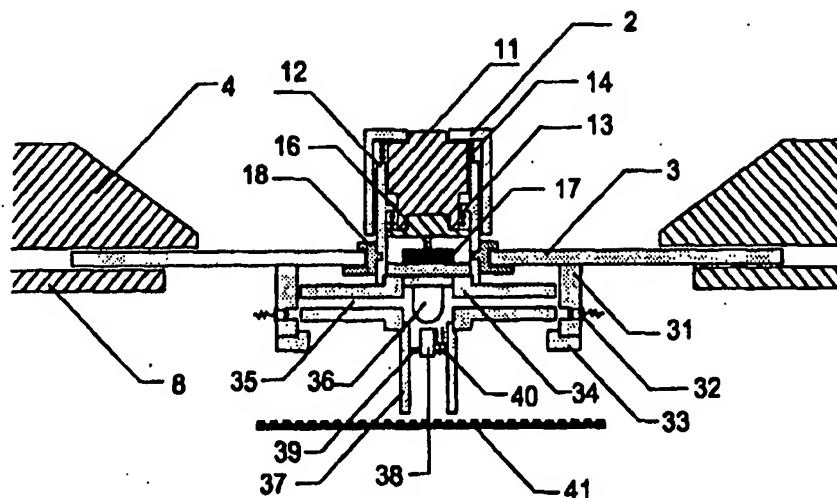
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(54) Title: CURSOR CONTROL DEVICE



(57) Abstract

A device for positioning and manipulating the screen cursor of PC's and other computers using software with a graphic interface. The invention has a finger-grippable handle (2) which the user can manoeuvre using the adapted writing and drawing movement of the hand for a precise and rapid relocation of the cursor. The movement of the handle is connected to two signal-generating systems, where the signal from the first system (41) gives a cursor movement which directly mimics the movement of the handle, and where the signal from the other system (32) gives a linear movement of the cursor where direction and speed are determined by a directional force or tilt applied to the handle.

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Cursor Control Device

The present invention relates to an input device intended for the positioning and control of the screen
5 cursor of computers utilising software with a graphic user interface.

The most important reason why computer use is steadily increasing is probably related to the development of
10 software which is generally applicable, in addition to a simplified interaction between the user and the machine enabling the layman without special computer training to operate the system without any particular difficulties. In addition to the traditional data input and program
15 activation via the keyboard, the user can now enter information and execute commands by selecting among menus and graphic symbols appearing on the computer screen. On many computers, this selection and execution is accomplished by use of an input device called a
20 "mouse".

A mouse is a small, hand-held tool that generates a position signal when moved on top of a surface. Concomitant to this, a graphic symbol on the computer
25 display (cursor, marker, pointer, arrow, etc.) mimics the mouse's motion in the form of a congruent track on the screen. By manipulating the mouse and thereby the screen cursor, the computer user can effectuate commands like "open file", "erase text", "check spelling", "draw
30 square", "save document", etc., or move the cursor to a position on the screen where a particular operation is to be performed.

The mouse is presently the most versatile and commonly
35 used input device on the market. Its main component is a rubber-clad ball resting on two cylinders or rollers that are mounted at right angles to each other.

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When the mouse is moved across a surface, the ball will, as a consequence of its contact with the surface, rotate in the direction of the movement. This movement is split into two components as a result of the ball's interaction with the two cylinders, i.e. its X-component and its Y-component in an X-Y plane. The cylinders' individual rotations are registered electronically (e.g. by means of an encoder), giving rise to a signal which is transformed by the processor and a mini-program (device driver) to cursor-movement on the screen. A movement of the mouse (and accordingly the ball) in an X-Y plane on the surface will elicit a corresponding movement of the cursor in the X-Y plane on the screen.

Modern microprocessors are extremely fast, and the time limiting factor in information processing is generally not the processor itself but the speed of information input. This is particularly the case when information is fed via a keyboard or other hand-operated input device, such as a mouse.

A number of different input devices for computers has been developed, of which the most popular ones are the following:

- a) Mouse; as described above (Microsoft, Logitech, Agiler, IBM, etc.)
- b) Track-ball; utilising the same electro-mechanical principle as the mouse, but the cursor is controlled by the thumb moving a ball that is resting on the two cylinders (Microsoft's Ball Point Mouse; IBM's Trackpoint; Appoint's Thumbelina; Logitech's Trackman Portable; Kraft System's Top-Track; Apple's PowerBook track ball, etc.)
- c) Optical mouse; operated in the same way as the mouse, but the movement is registered optically, e.g. by use of a reflecting mat (Mouse Systems Corp., etc.)

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- d) Pen mouse; using the same electro-mechanical principle as the mouse, but the ball and the cylinders are incorporated in the "tip" of a pen-like tool (Appoint's MousePen Professional, etc.)
- 5 e) Arrow-keys (present on all computers with keyboard; minimum 4 keys)
- f) Digitalisation board; plate with separate pen tool, where information regarding the pen-tip's position relative to the plate is registered and transmitted to the computer in digitised form (Summasketch, 10 etc.)
- g) Joy-stick or directional button; tool which can be bent or pushed in different directions relative to a perpendicular, normal position. This bending evokes a continuous movement of the cursor in a direction 15 (and optionally, with a speed) that is dependent upon the direction and inclination relative to the normal position (IBM's Trackpoint II, GRID's IsoPoint, Suncom Technologies' ICONTroller etc.)
- 20 h) Light pen; optically-based interaction with the screen (IBM etc.)

Some of these input devices are particularly developed for portable computers (including laptop- and notebook- 25 PC's).

However, the aforementioned input devices have a number of deficiencies and drawbacks. The most important are the following:

- 30 1) The movement of the mouse across a surface is guided by muscles that are not trained for very precise manoeuvring. Accordingly, the accompanying movement of the screen cursor is not particularly precise. While the mouse's precision is sufficient for most practical purposes, it is not very well suited for 35 graphics and free-hand drawing. The mouse as a separate entity has furthermore limited

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applicability in conjunction with portable computers (laptops and palmtops). Further, time is lost in ensuring precise positioning of the cursor over icons or symbols, in giving commands and in switching between keyboard input and mouse input.

- 2) The movement of the hand guiding the mouse may cause injuries, particularly as a result of frequent use.
- 10 3) The ball and the rollers are easily coated with dirt, leading to an uncontrolled and erratic movement of the cursor after a short time in use.
- 15 4) The optical mouse gives a somewhat better precision than the ball-mouse, but relies upon guidance by the same muscle groups. The optical mouse requires, in addition, a stiff, reflecting plate as support (approx. 20 x 20 cm).
- 20 5) The pen-mouse offers initially better precision, as the user utilises the same muscles as are used for writing. However, as the common variety of the pen-mouse is also based upon a rolling ball (which is considerably smaller than the one employed by the classical mouse), this pointing device is very sensitive to dirt and wear, and therefore gives a less precise movement of the cursor after a short time in use.
- 25 6) The track-ball is moved by the thumb, with a resulting inaccurate movement of the cursor. It is, however, less subject to dirt and wear than the classical mouse, and is well suited for incorporation in portable computers.
- 30 7) The arrow keys are useless for rapid and precise movement of the cursor.
- 35

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- 8) Joy-sticks may give a rapid but not very precise movement of the cursor, and are not suited for graphical work.
- 5
- 9) The Digitalisation board is well suited for graphical work, but is not particularly useful for interactive communication with the computer, e.g. for activation of program functions. It is also expensive.
- 10
- 10) The light pen is developed for use with specially designed equipment, and it is not particularly suited for modern program interaction and for graphical work.
- 15
- Ideally, the input device should
- 1) be sufficiently exact to be used for graphical work,
 - 20 2) allow for rapid and continuous movement of the cursor across the entire screen, and rapid and precise positioning and repositioning of the cursor
 - 3) be well suited for precise and rapid interaction with computer and program via the graphical interface (menus, icons, etc.)
 - 25 4) be suitable for incorporation both in stationary and portable computers, in a way that the same technique could be applied for all types of machinery,
 - 30 5) allow for complete integration in a keyboard or computer chassis,
 - 35 6) allow for unlimited cursor movement
 - 7) allow for rapid execution of commands

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- 8) require minimum changes of grip during operation
- 9) provide logical cursor response, i.e. cursor
5 responds as intuitively expected
- 10) have good ergonomic properties
- 11) be simple, durable, hard wearing and inexpensive.

10

Pursuant to the investigation of new concepts suitable as input devices for computers, the inventor has arrived at the surprising conclusion that if some of the elements of known systems are supplied with additional
15 components and put together in new configurations other than the ones hitherto used, this can form a basis for an entirely new class of input devices that in a far better way than existing equipment seem to satisfy the ideal requirements as discussed above.

20

According to the present invention there is provided a cursor control device comprising a finger-grippable member, said member being mounted so as to be movable in all directions within a co-ordinate plane; said device
25 further comprising first signal generating means for detecting movement of said member within said co-ordinate plane and for translating said movement to electronic signals indicative thereof, said signals being provided to a cursor control means for moving the
30 cursor an amount proportional to the amount of movement of the finger-grippable member; wherein said device further comprises second signal generating means responsive to a force applied to said finger-grippable member or to another part of the device, said second
35 signal generating means being operable independently of said first signal generating means and comprising a time-proportional system wherein the length of cursor

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movement is dependent upon the duration of application of said force.

The finger-grippable member is preferably a short handle
5 that is operated like a pen. In incorporating a pen-type handle, the invention benefits from the writing and drawing abilities of the hand for a rapid and controlled movement of the handle, and consequently the cursor.

10 The device incorporates two separate signal generating systems which can operate independently. In the first system the distance moved by the cursor is proportional to the distance moved by part of the device. The paths of movement of the device part and the cursor are
15 generally congruent. This first system is generally referred to as the "length-proportional system".

This is combined with a second system wherein the length of cursor movement is dependent upon the duration of
20 command execution (e.g. pushing, bending, lifting or depressing part of the device). In constant-speed systems, the length of cursor movement is proportional to the duration of command execution. In variable-speed systems the length of cursor movement may be dependent
25 on the duration of command execution, on the force applied or on the degree of bending a device part relative to its normal position. For simplicity, the second system is generally referred to as the "time-proportional" or the "time/force-proportional" system.

30 The handle as employed in the present invention, is in preferred embodiments mounted to, or can be attached to a movable plate support that is incorporated in the device itself. This construction combines robustness
35 with precision, with the additional possibility of miniaturisation and integration in different computer sizes. Further, using a pen-type, finger-grippable

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handle, the user, in a similar way as with the pen-mouse and the Digitalisation board, is encouraged to utilise the hand's long-term training in writing and drawing.

- 5 In other embodiments of the invention, the pen-type handle is not attached to, but is allowed to move freely within a confined area on the surface of a stationary plate support.
- 10 The length-proportional signal generating system may be realised in several different ways, any of which may be preferable depending upon the particular application. The first signal generating system may be, e.g., a roller-based system, similar to that used in the mouse.
- 15 Alternatively, the movement of the device (or rather, a device part) in the X-Y co-ordinate plane may be detected using an optical sensing system which detects light from emitters reflected from an optical grid system. The optical signals are converted into
- 20 electrical signals indicative of the position or movement of the cursor control device in the X-Y plane.

The time/force-proportional system may also be effected in different ways. Pressure sensors may be used to

25 detect a directed force applied to part of the device, e.g. a ring constituting the outer physical limit of the handle's movement area. Alternatively, an optical system may be used to detect a tilting movement of a device part.

30

- In one preferred arrangement a handle is mounted in a plate support via a resilient collar which transmits lateral movement to the plate but permits a degree of tilt of the handle. The degree of tilt may be detected
- 35 by force sensors or by an optical angle-measuring arrangement. This and other arrangements permit the first and second signal generating means to operate

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simultaneously and independently, although the second signal generating system will normally be evoked while pushing the handle against the physical barrier constituting the outer limit of its active area.

5

The handle's active area is circular in all preferred embodiments, although it can also have other forms (square or rectangular, with or without rounded corners; oval, etc.)

10

Preferred embodiments will now be described, by way of example only, with reference to the accompanying drawings, wherein:

15 Fig. 1 shows a perspective view of a cursor control device according to the present invention;

Fig. 2 shows a cursor control device incorporated in a portable computer;

20

Fig. 3 shows the cursor control device as a separate unit;

25 Fig. 4 shows the cursor control device in different positions,

Fig. 4A shows the handle or finger-grippable member in the middle of the circular active area,

30 Fig. 4B and Fig. 4C show the effect of moving the handle to different positions within the active area, and

Fig. 4D illustrates the effect of using the second signal generating system ;

35

Fig. 5 shows the use of an electromechanical roller movement detection system;

- 10 -

Fig. 6A and Fig. 6B are sections in plan and elevation showing a preferred embodiment of the electromechanical system;

- 5 Fig. 7A and Fig 7B are a vertical cross-section and plan view showing the switching function of the device according to a preferred embodiment;

- 10 Fig. 8 is a sectional view of a roller-based system, incorporating a second signal generating system in the handle;

- 15 Fig. 9A is a detailed view of a preferred embodiment of the second signal generating system and Fig 9B shows in plan the arrangement of pressures;

Figs. 10A-D illustrate the different modes of operation of the device;

- 20 Figs. 11A and 11B show in elevation and plan a preferred arrangement of pressure detectors for use as the second signal generating system;

- 25 Fig. 12 shows a similar embodiment to Fig. 11 using different dimensions;

Fig. 13 shows the embodiment of Fig. 12 incorporated in a lap-top computer.

- 30 Fig. 14 shows how the pressure detectors can be expanded and incorporated in a sensing area;

- 35 Fig. 15 shows a cross-section of a cursor control device of the present invention using an opto-electrical movement detecting system.

Figs. 16A-C show part of the system shown in Fig. 15;

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Figs. 17A-C show side views of different positions of the second signal generating system;

5 Fig. 18 shows a top view of an opto-electrical signal generating system detecting pivotal movement of the finger-grippable member.

10 Fig. 19 shows an alternative second signal generating system for detecting pivotal movement of the finger-grippable member;

Fig. 20 shows a different embodiment of the opto-electrical system;

15 Fig. 21 shows a preferred position of the cursor input device relative to a computer keyboard;

20 Fig. 22 is a sectional view of the cursor control device shown in Fig. 21;

Figs. 23A and 23B show a further embodiment of the cursor control device of the present invention; and

25 Fig. 24 shows the embodiment of Fig. 23 incorporated in a computer.

Fig. 1 shows a cursor control device 1, in accordance with the invention, consisting of a finger-grip 2 and a circular plate support or base plate 3 incorporated in a computer or device chassis 4. The diameter of the visible part of the base plate 3, which is approximately equal to the active area of the finger-grip, may be between about 0.5 cm to 8 cm and is typically between 1 cm and 4 cm. (Other embodiments of the invention may
35 utilise other technical solutions where the base plate is partly or totally obscured, and where the

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relationship between the active area and the visible part of the base plate is different from the one cited.)

The cursor control device 1 can be incorporated in a portable computer as shown in Fig. 2 or can be a separate unit as shown in Fig. 3. In the latter case, the device may be connected to a computer by a cable, by infra-red transmission, by other electromagnetic transmission or as a plug-in module for keyboards or PC's.

Referring to Figs. 4A-D, the circular, visible part of the base plate 3 shown in Fig. 4A corresponds to the active area of the finger-grip 2. This area corresponds to the circular area 6 on the computer screen 5 in which the cursor 7 is permitted to move in response to finger-grip movement, while just the first, length-proportional system is in operation.

Fig. 4B shows the effect of moving the finger-grip 2 to the "8 o'clock" position within the active area, resulting in a similar movement of the cursor 7. In Fig. 4C, the cursor 7 is moved to the "2 o'clock" position by moving the finger-grip 2 diametrically across the active area.

Fig. 4D illustrates the second signal-generating system (the time/force-proportional system) in operation. In this particular embodiment, this system is activated by pushing the finger-grip 2 against the physical limit of the active area. The effect of this is that the screen cursor 7 is moved beyond the circular screen area 6 in the same direction as the applied force F. The cursor will continue to move in the same direction as long as the applied force is maintained or until the finger-grip 2 is pushed in another direction.

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One of the sub-systems constituting the input device is shown schematically in Fig. 5. In this embodiment of the invention, a finger-grippable member in the form of a handle 2 is attached to a circular plate 3 resting on two rollers 20 which are mounted at right angles to each other. A movement by the handle 2 in the X-Y plane will be split in an X- and a Y- component as the movement of the plate 3 is transformed into a rotation of the two rollers 20.

10

In order to act as a proper support and enable the circular plate 3 to be moved freely and evenly in all directions, the device may incorporate two extra support-rollers as shown in Figs. 6A-B. However, only two of the four rollers (the position-rollers) are connected to signal-generating components. Fig. 6B shows a side view of this sub-system (which is incorporated in all roller-based varieties of the input device). Fig. 6A shows an optimal configuration of four rollers 20 to give maximum support and ease of movement to the base plate 3. (Two of the rollers may be substituted by non-movable, supporting structures of equal height). Two of the rollers positioned at a right angle to each other are connected to encoders 21. A movement of the plate 3 will cause the encoders 21 to send a two-component, pulsed signal to the computer (here via connection cables 9), where the number of pulses is proportional to the length travelled by the finger-grip in two dimensions. Fig. 6B shows a side view of the roller-based signal generating system, where the rollers 20 and the chassis 4 act as movement guides for the base plate 3.

Inside its circular, active area, the finger-grip 2 can be moved freely in all directions, and the grip can be pushed and pulled and thereby attain different vertical positions. When the handle is lifted up or pushed down,

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a switch (see Figs. 7A-B) in the handle 2 will disconnect communication or give specific signals to the computer and the software. As seen in Fig. 7A, the handle or finger-grip 2 comprises an outer shell
5 attached to an inner "piston" 11 which can be moved vertically within a cylinder 12 attached to the base plate 3 via a flexible, profiled ring or collar 18. A projection or lip 13 on the inside of the cylinder 12 limits the vertical movement of the piston 11. The
10 profiled ring 18 is made of a durable, elastic polymer and attaches the finger-grip 2 to the base plate 3 at the same time permitting pivotal movement of the grip 2. The piston 11 actuates a plunger 16 of microswitch 17. When the handle 2 is moved horizontally with the switch
15 in the "normal position", a signal that is generated as a result of roller movements will be sent to the computer. With the switch in the "0-position" e.g. an upper position, the handle 2 can be moved horizontally without transmitting any signals to the computer. (This
20 is equivalent to lifting the mouse from the support and putting it down in a new position.) With the switch in an "activator position" e.g. a lower position, an extra signal is generated in addition to the positioning signal, which is equivalent to pressing one of the push-
25 buttons of the mouse.

A whole range of different alternatives exists for the switch construction and the spatial arrangement of the switch in the input device. In the present invention,
30 it is incorporated in the handle 2. This is advantageous in that activation and deactivation signals can be given to the computer without changing the grip. A potential demand for more than three switch positions can be satisfied by equipping the switch with more than
35 three positions, or by incorporating extra switches elsewhere on the handle or on the device.

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It is recommended that the "normal position" of the switch is a mechanically preferred one. This can be achieved e.g. by incorporating stop devices. In a similar way, the handle 2 can be equipped with spring systems allowing for an automatic return to a central position when not in operation.

The handle 2 itself can be equipped with a variety of functions and be given different shapes according to its particular use. In one embodiment of the invention it has the form of a pen. The "pen-handle" can be moved freely within the active area using a conventional writing technique.

Although it is possible to increase or decrease the "action radius" of the screen cursor by modifying the size of the active area of the finger-grip or by modifying the signal/response relationship of the transmitted signal, the utility of the input device would be limited if the movement of the cursor was restricted by the finger-grip being confined to the said, active area. This would be the case if only the first, length-proportional system was available.

The presently described input device solves this problem by incorporating a second, time/force-proportional system. These two systems operate independently, and in some embodiments simultaneously irrespectively of the handle position and without the user having to change grip.

The solution employed by the device to extend the action radius of the screen cursor indefinitely, even if the movement of the handle itself is limited to within the active area, is a translation or repositioning of the "action-circle" of the screen cursor via a signal which is sent to the computer independently of the signal

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giving information about the handle's X-Y position. The same infinite cursor range can be obtained with a mouse by lifting and repositioning it repeatedly.

- 5 This translational movement can e.g. be achieved as a result of pushing the handle 2 against the physical barrier constituting the outer limit of the circular, active area (Figs.4D, 10B-C) or pushing sideways along the surface of a surrounding pressure-sensitive area
10 (Fig. 10D). The reason why these actions cause a movement of the "action-circle" is that connected to the handle or the rim are mounted pressure-sensitive sensors or similar devices that detect a horizontal, directed force applied to the handle or to the said surrounding
15 area.

The vectorial force F can be detected by employing sensors that are arranged in different configurations. In one embodiment of the invention shown in Figs. 9A and
20 9B, four pressure-sensors 25 are used. The cylinder of the finger-grip 2 penetrates base plate 3 via a flexible ring 24. The grip is restricted in its movement by a sleeve or washer 23 on the upper side and a circular plate 26 on the lower side of the base plate 3. The
25 pressure sensors 25 are located between the circular plate 26 and the base plate 3. The detectors may be based upon piezo-electric crystals, pressure-dependent capacitors or other systems known in the art. A pivotal movement of the finger-grip 2 will generate signals of
30 varying strength from the four sensors 25 and these signals can be transformed to information about the direction and force of bending of the finger-grippable element. Other systems known to be used in joy-sticks and similar devices can also be used for this purpose.

35

In the arrangement shown in Figs. 11A-B, the four sensors 27 are placed between the outer edge of an

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- inflexible ring 28 and the computer chassis 4. (The sensors themselves will be incorporated in the device and hidden from view, but are shown explicitly in Figs. 11B and 12 to indicate their position.) The ring 28 surrounds the active area around the finger-grip 2. When the grip 2 is pushed against the ring 28, the sensors 27 will detect direction and force applied to the grip.
- 10 A similar construction is shown in Fig. 12. However, in this construction, the dimension and position of the surrounding ring 29 is different. This system can be operated independently of the rest of the device, by dragging or pushing the ring 29 by means of the fingers.
- 15 The ring 29 does not actually move but the detectors 27 sense the frictional force applied in a particular direction. The surface of the ring 29 should preferably be covered by a rubber-type material.
- 20 Fig 13 shows the application of this embodiment to a lap-top computer, and Fig. 14 shows how the sensor area can be expanded.

The sensors will generate an electrical signal which, depending upon which of the four sensors are affected, and the magnitude of the pressure, will be transformed to a signal that gives information on both direction and force. This signal will be transformed by the device driver to a continuous movement of the screen cursor, characterised by a specific direction and optionally, speed.

When the handle is pushed against the inner surface of the ring in a certain direction, the cursor is moved continuously in the same direction as long as the pressure is maintained. This will move the action circle of the cursor to a desired position on the

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screen. Thereafter, a more precise manoeuvring of the cursor can be performed using the length-proportional system.

5 If the handle is moved simultaneously with a pressure-sensitive area being subjected to a horizontal force (F), e.g. by the hand (Fig. 10D), a compounded cursor movement is obtained. This is similar to the muscular activity used in writing or drawing: The thumb and the
10 index finger take care of the "fine" manoeuvring of the pen, while the arm "pulls" the hand across the paper with the result that the drawing or written line attains the intended dimensions. An embodiment suitable for this mode of operation is shown in Fig. 14.

15

The main difference between the use of this embodiment of the invention and a conventional writing movement, is that while writing leads to a movement of the hand across the paper, the muscular activity against the
20 pressure-sensitive support while using the invention is isometric; i.e. it does not lead to a net movement of the hand.

Because the horizontal force applied to the handle or
25 against the support affects pressure-sensitive sensors, the signal being transmitted to the computer will be equivalent to what would have been obtained if the handle's active area had an infinite extension.

30 The design and the electro-mechanical components used as a basis for signal generation in the previously described embodiments of the invention are used merely to illustrate the main principles. One can also use other electronic, electro-mechanical, optical, opto-
35 mechanical or acoustic principles as a basis for the positioning of a screen cursor.

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Several of these systems may have advantages over the roller/plate and pressure sensor systems. Examples of such devices will now be described with reference to Figs. 15-22. (The drawings are provided to illustrate principles, and not to act as basis for construction.)

In one embodiment, the device uses an optical or opto-electrical signal generating system. In this embodiment, the two different control modes of the device are realised by two opto-electrical signal generating systems, one responding to a horizontal movement of the base plate and the other responding to a pivotal movement of the handle. Fig.15 shows a device according to such an embodiment, incorporated in the chassis 4 or keyboard of a personal computer.

The control device is located in a recess in the keyboard which has sloping walls giving room to grip the handle 2 and move it in all directions. A guide plate 8 together with the recess 4, creates a slot for permitting a guided, horizontal movement of the base plate 3. The finger-grippable handle 2 and opto-electrical signal generating means are mounted on the base plate 3.

The handle or finger-grip 2 comprises an outer shell attached to an inner "piston" 11 which can be moved vertically within a cylinder 12 attached to the base plate 3 via a flexible, profiled ring or collar 18. A projection or lip 13 on the inside of the cylinder 12 limits the vertical movement of the piston 11. The profiled ring 18 is made of a durable, elastic polymer and attaches the finger-grip 2 to the base plate 3 at the same time permitting pivotal movement of the grip 2.

A micro-switch 17 connected to the piston 11 is used for interrupting signal transmission when the finger-grip 2

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is pulled upwards and sending an activation signal to the computer when the finger-grip 2 is pushed downwards.

The time/force-proportional system comprises an optical sensor 32 mounted on the base plate 3 and a horizontal light guide 35 guiding light from a light emitter 36 towards the optical sensor 32. The light guide 35 is preferably circular although four tubular guides arranged in the form of a cross may also be used. The light guide 32 is composed of two parallel plates 34 and the space between the plates 34 is filled with air or some other transparent medium such as glass, polymers, etc. The light guide 32 may also be equipped with a system of lenses, focusing, dispersing or otherwise guiding the light according to a desired pattern. A stop 33 prevents the light guide 35 from being tilted beyond the optimum position for maximum illumination of the sensor 32.

The light emitter 36 may be an infra-red emitter or similar light-emitting lamp providing radiation with a uniform spatial distribution. Although a single emitter is shown, providing radiation for all of the opto-electrical systems, this can be replaced by several emitters positioned opposite each of the light sensors.

The length-proportional system comprises a vertical light guide 37 guiding light from the emitter past a light splitter 38 via a lens 39, down to a reflecting grid 41 and reflects light up to the sensors 40. These light sensors 40 detect the guided light and detect changes in illumination caused by the light beam travelling across a grid 41 of reflecting and non-reflecting areas after the base plate 3 is moved horizontally. This will create an output signal similar to that created by the mouse encoder. The frequency of this signal can be adjusted by the grid spacing and by

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the number of aligned light sensors. The direction of motion is determined based on the sequence of the signal output from the sensors.

5 Figs. 17A-C and 18 show more detailed views of the opto-electrical signal which detects pivotal movement of the finger-grip (the time/force-proportional system). Light sensors are arranged opposite each other. Pivotal movement of the finger-grip 2 results in an illumination
10 of the light sensors 32 from the light guide. The amount of light that each sensor receives depends upon the degree and direction of the movement of the finger-grip.

15 In use, the finger-grip is held between the thumb and the index finger or the tip of the finger may be put on the top of the grip to move it. Movement of the hand or finger(s) in a horizontal direction will cause a corresponding movement of the base plate, thus causing
20 the length-proportional system to generate a pulsed signal. The pulses generated will be transmitted to the computer and transformed into screen cursor movement.

The second signal generating system detects pivotal
25 movement of the finger-grip. This pivotal or sideways bending motion can be obtained anywhere within the circular area of movement of the grip. However, normally the pivotal movement will be executed while pushing the finger-grip 2 or base plate against a
30 physical barrier constituting the outer limit of the active area. This allows the finger-grip 2 to be bent without a simultaneous movement of the base plate 3 since this is prevented from further outward movement by the design of the system.

35

This pivotal bending of the finger-grip 2 leads to a varying degree of illumination of the light sensors 32

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with the amount of light each sensor 32 receives being dependent upon the degree and direction of bending. This provides an electrical output signal from the sensors that can be transformed into vectorial
5 information, i.e. information regarding the speed and direction of cursor movement. The basic principle of this system is illustrated in Fig. 17.

Fig. 17 is a side view of three different positions of
10 the signal generating system based upon pivotal movement of the finger-grip. Fig. 17A shows the normal position when no signal is generated. Figs. 17B and C show two situations with increased bending of the finger-grip, leading to 50% (17B) and 100% (17C) illumination of the
15 light sensor.

The pivotal bending of the finger-grip 2 will also cause a slight change in the angle of inclination of the vertical beam which would cause a momentary, brief
20 movement of the cursor. However, this does not affect the overall movement of the cursor to a significant extent.

The above-described system is an alternative embodiment
25 for detecting a vectorial force being applied to the finger-grip 2, in addition to the electromechanical systems discussed previously. Alternatively, the signal generating system employed for detecting horizontal movement of the base plate, i.e. the system employing a
30 reflecting grid, can also be used to detect the vectorial force.

In the embodiment shown in Fig. 19, the system based upon measuring the amount of incident light by varying
35 the aperture of the light sensor is replaced by a grid/reflection system. Four grids with horizontal reflecting stripes 45 are mounted at the former location

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of the light sensors and the light sensors themselves 44 are mounted on the light guide opposite the grid. A downward movement of one half of the light guide, following bending of the finger-grip 2, makes the light beam 42 cross a certain number of reflecting stripes. Again, this generates a number of electrical pulses which can be transformed into cursor speed information. The different sensors 44 will yield a different number of pulses according to the direction and degree of finger-grip bending, thus creating similar vectorial information as described for other systems.

Rather than generating the vectorial information by pivotal bending of the finger-grip, this can be created by a secondary sideways movement of the grip as shown in Fig. 20. However, this can only be executed when the grip 2 and base plate 3 are pushed against the outer edge of the movement area, thus being prevented from further outward movement. Of course, the principle shown here for detecting secondary sideways movement can be replaced by a reflecting grid system discussed previously.

The position of the cursor control device relative to the keyboard is particularly significant both in relation to ergonomics and ease and speed of operation. Bearing this in mind, the present invention also discloses a solution to this as shown in Figs. 21 and 22. A semi-circular indentation or recess is provided in the space bar 47 and this forms part of the movement area of the finger-grip. This partial removal of the traditional space bar 47 allows for a very close integration of the input device in the keyboard, permitting the finger-grip to be manoeuvred with the thumb or gripped between the thumb and the index finger while the other fingers are resting in their normal position on the keyboard. One very advantageous

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consequence of this is that the user can switch very rapidly between keyboard input and cursor input without changing his hand position.

- 5 This embodiment is shown in more detail in Fig.22. The semi-circular recessed area 47 has sloping side walls to permit ease of operation of the handle 2 while gripped between the thumb and index finger.
- 10 An additional feature of this embodiment is that it permits a functional coupling between the finger-grip 2 and the space bar 47. Depressing the space bar 47 while the finger-grip 2 is in the up or down position may provide two extra cursor input commands, similar to
- 15 using a right and middle mouse button. Alternatively, this function coupling may render the "up" position of the finger-grip obsolete, since a simultaneous depression of the grip 2 and the space bar 47 may be given a code status as interrupting cursor signal
- 20 execution, permitting the grip to be manoeuvred without creating any cursor movement, equivalent to lifting and repositioning the mouse. Using this combination permits the thumb or index finger to rest on top of the finger-grip 2 during the manoeuvring process, thus further
- 25 reducing the need for reposition of the hand relative to the keyboard during active cursor manipulation.

A similar combined action of finger-grip 2 and space bar 47 can be achieved by, or extended to encompass, other

30 keys, for example "shift", "control" or "alt" in combination with the finger-grip manipulation.

In general, the finger-grip or handle 2 is made as simple as possible, with no additional push-buttons. The

35 switch control is executed by merely lifting and depressing the grip. While the finger-grip is in the normal position, a horizontal movement will lead to a

- 25 -

corresponding movement of the cursor. When the grip is lifted, the signal generation is interrupted and the finger-grip can be repositioned without influencing the position of the cursor on the screen. Thus, it is not
5 necessary to change one's grip to actuate the switch mode.

Cursor control devices utilising a short finger-grip 2, are particularly suited for incorporating into small,
10 portable computers (lap-tops, palm-tops etc.), where it is important to minimise the exposure of the handle in order to avoid conflict when closing the computer lid. For stationary equipment, the handle may have other forms or dimensions.

15 An alternative to using a short finger-grip for reducing the size of the device, is to employ a separate, pen-like writing tool 49 as shown in Figs. 23A-B and 24. When the tip of this tool is moved on top of a
20 stationary base plate 48, its movement or position is registered by a system which is based upon acoustic, optical, electromagnetic, electromechanical or other principles known to the art. This constitutes the length-proportional system equivalent to the
25 electromechanical and opto-electronic systems as described above. In addition, this embodiment incorporates a time/force-proportional system in the form of pressure sensitive detectors 27 connected to an inflexible ring 28 that constitutes the outer limit of
30 the pen's active area, against which the pen is pushed when trying to move it outside the said area. As with the embodiment shown in Fig. 14, this solution is particularly suited for utilising the hand's long-term training in writing and drawing.

35

CLAIMS

1. A cursor control device comprising a finger-grippable member, said member being mounted so as to be
5 movable in all directions in a co-ordinate plane; said device further comprising first signal generating means for detecting movement of said member in said co-ordinate plane and for translating said movement to electronic signals indicative thereof, said signals
10 being provided to a cursor control means for moving the cursor an amount proportional to the amount of movement of the finger-grippable member; wherein said device further comprises second signal generating means responsive to a force applied to said finger-grippable
15 member or to another part of the device, said second signal generating means being operable independently of said first signal generating means and comprising a time-proportional system wherein the length of cursor movement is dependent upon the duration of application
20 of said force.
2. A cursor control as claimed in claim 1 wherein said finger-grippable member (2) is attached to a movable plate support (3) such that movement of said member (2)
25 in said co-ordinate plane causes corresponding movement of said plate support (3) and said first signal generating means detects movement of said plate support.
3. A cursor control device as claimed in claim 1 or 2
30 comprising a further signal generating means (17) responsive to movement of the finger-grippable member (2) in a direction out of said co-ordinate plane to produce control signals.
- 35 4. A device according to any preceding claim wherein said first signal generating means comprises an electromechanical signal generator system.

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5. A device according to claim 4 wherein said electromechanical signal generator system (Figs. 6A-B) comprises at least two rollers (20) placed at right
5 angles to each other, wherein two of the rollers (20) are coupled to signal generating means (21), and wherein the rollers (20) by their individual rotation generate a two-component signal which is transformed via suitable software and/or processor to information giving rise to
10 a change in the position of the cursor on the screen, such that rotation of one of the rollers leads to a movement parallel to the X-axis, while rotation of the other roller causes the cursor to move parallel to the Y-axis in a co-ordinate system projected on the screen,
15 wherein the rotation of the rollers is mediated by the movement of a plate support (3) resting on the rollers (20), and wherein the plate support (3) can be moved in all directions in a plane parallel to the axes of the rollers by means of said finger-grippable member (2).

20

6. A device according to any one of claims 1 to 3 wherein said first signal generating means comprises an opto-electronic signal generator system.

25 7. A device according to claim 6 wherein said opto-electronic signal generating system (Fig.15) comprises a base plate (3), light emitting means (36), and optical sensing means (40) mounted on said plate (3) for detecting reflected light from light emitting means
30 (36), and a light reflecting member (41) that said support plate (3) can move relative to whereby the degree of relative movement is detected by said sensing means (40).

35 8. A device according to any preceding claim wherein said second signal generating means comprises means arranged to detect a vectorial force or angular

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displacement applied to said finger-grippable member (2) or to another part of the device and provides a signal indicative of the direction and magnitude of said force or angular displacement for corresponding control of
5 said cursor.

9. A device according to claim 8 comprising optical light detecting means (32,35,36) to detect vectorial force by lateral displacement of finger-grippable member
10 (2) relative to base plate (3).

10. A device according to claim 9 wherein said opto-electronic signal generating system (Fig.20) comprises a base plate (3), optical sensing means (32) mounted on
15 said plate (3) for detecting light from light emitting means (36), and resilient mounting means (18) for resiliently mounting said finger-grippable member (2) within said support plate (3) such that said member (2) can move relative to said plate (3) whereby the
20 direction and magnitude of lateral displacement is detected by said sensing means (32).

11. A device according to claim 8 comprising optical light detecting means (32,35,36) to detect angular
25 displacement of finger-grippable member (2) relative to base plate (3).

12. A device according to claim 11 (Fig. 15) wherein said opto-electronic signal generating system comprises
30 a base plate (3), optical sensing means (32) mounted on said plate (3) for detecting light from light emitting means (36), and resilient mounting means (18) for resiliently mounting said finger-grippable member (2) within said support plate (3) such that said member (2)
35 can move relative to said plate (3) whereby the direction and angular displacement is detected by said sensing means (32).

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13. A device according to claim 8 comprising pressure sensors (25, 27) for detecting a vectorial force.

5 14. A device according to claim 13, wherein pressure sensors are connected to a support or another delimited area of the device which can act as a hand or finger rest, where the pressure sensors are mounted and arranged such that they detect the direction and
10 magnitude of a force applied to the support.

15 15. A device according to claim 13 or 14, wherein the pressure sensors (27) are connected to a ring (28) that constitutes the outer limit of the active area, against which the finger-grippable member (2) will be forced when trying to move it outside the area.

16. A device according to claim 13, wherein pressure sensors (25) are connected to the finger-grippable
20 member (2), where the pressure sensors (25) are mounted and arranged such that they detect the direction and magnitude of a force applied to the said member (2).

17. A device according to any of claims 8 to 16 wherein
25 the cursor is controlled to move in a direction dependent on the direction of the said applied force or angular displacement of a device part.

18. A device according to any of claims 8 to 16 wherein
30 the cursor is controlled to move in a direction dependent on the direction of the said applied force or angular displacement of a device part, and by a speed dependent on the magnitude of the force or degree of angular displacement.

35 19. A device according to any preceding claim, wherein said device further comprises one or more switches (17)

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in said finger-grippable member (2) that, depending on their position, represent a series of different transmission modes including; a) "O-position": No signal transmission between cursor control device and processor; and b) "Normal-position": Normal signal-transmission between cursor control device and processor wherein the cursor responds to the movement of said finger-grippable member; c) "Activator-position"; wherein a specific signal is provided to the processor, said specific signal being independent of the movement generating signals, and being capable of being transmitted simultaneously with these; and, optionally, d) "Alternative activator-position", as c), but providing the possibility of an extra signal.

15

20. A device according to claim 19, wherein said switch(es) (17) can attain different positions depending upon whether the finger-grippable member (2) is retracted or depressed, or rests in an intermediate position.

20

21. A cursor control device as claimed in any preceding claim wherein said finger-grippable member comprises a pen-like handle.

25

22. A cursor control device comprising a finger-grippable member (2), said member being attached to a movable plate support (3) incorporated in the device, said plate support (3) being movable in all directions within a delimited area of a co-ordinate plane, said device further comprising means (20,32) for detecting movement of the plate support (3) within the co-ordinate plane and for translating said movement to electronic signals indicative thereof, said signals being provided to a cursor control means; wherein said device further comprises switching means (17) arranged to switch in

35

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response to movement of said member (2) towards and away from said plate support (3).

23. A cursor control device as claimed in claim 22,
5 wherein said switching means (17) comprises a piston (11) attached to said finger-grippable member (2), said piston (11) being axially movable within a cylinder (12) attached to said plate support (3) to actuate a switch plunger (16).

10

24. A cursor control device as claimed in claim 22 or 23 wherein said switching means (17) has three positions, in which it provides three different signals to the cursor control means.

15

25. A computer keyboard (4) incorporating the device of any preceding claim.

26. The computer keyboard of claim 25 wherein said
20 device is mounted in a recess at least partly formed in key(s) of said keyboard (4).

27. The computer keyboard of claim 25 wherein said
device is mounted in a recess (47) at least partly
25 formed in the spacebar (47) of said keyboard (4).

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Fig. 1

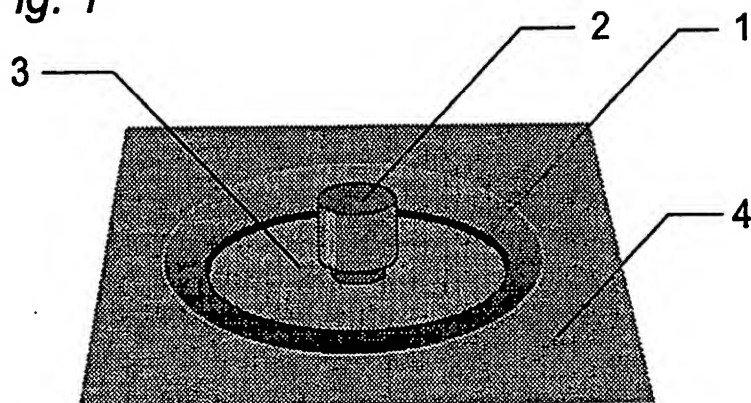


Fig. 2

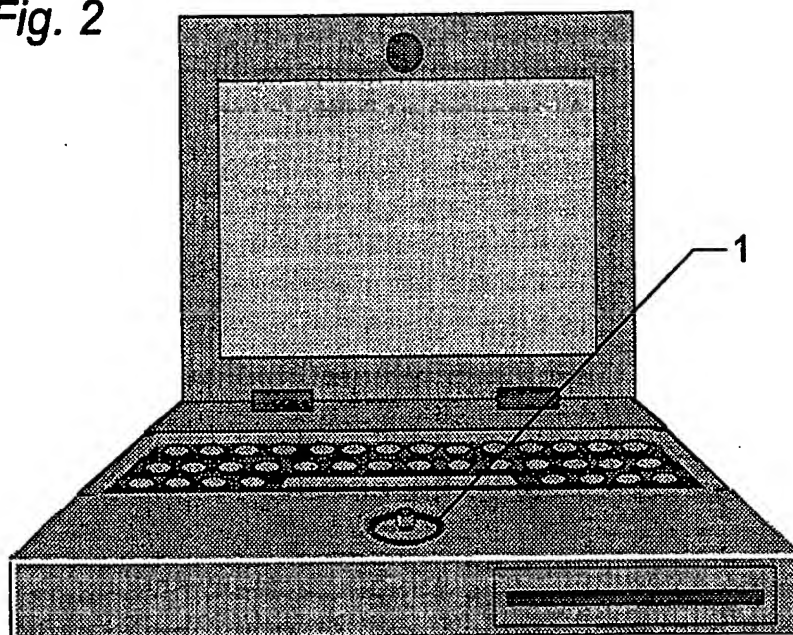
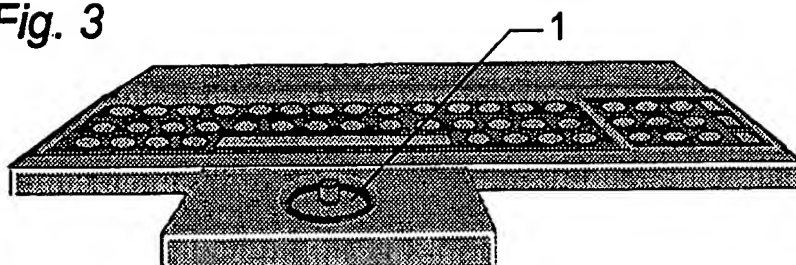


Fig. 3



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Fig. 4A

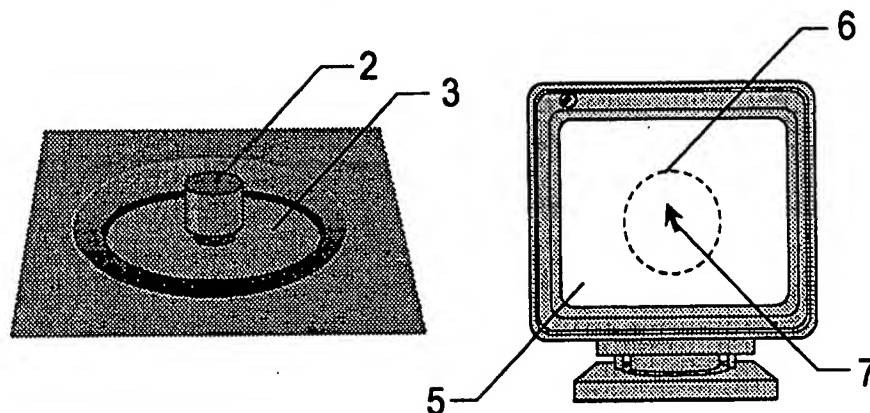


Fig. 4B

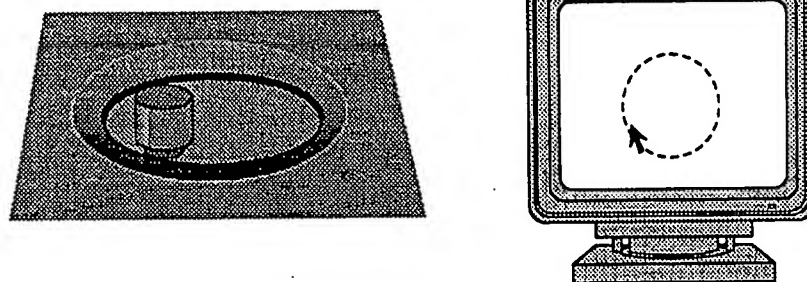


Fig. 4C

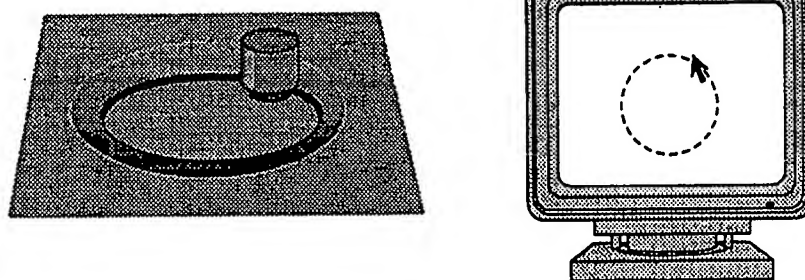


Fig. 4D

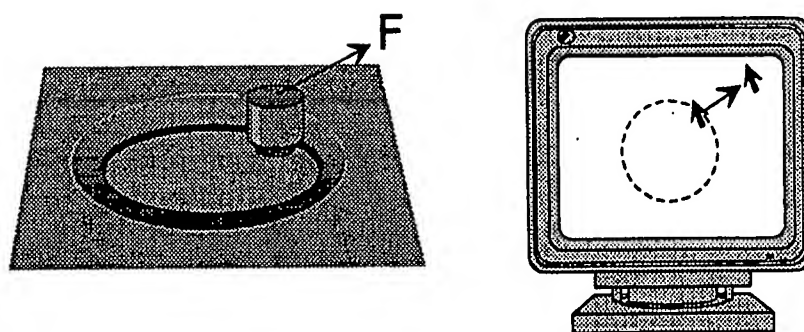


Fig. 5

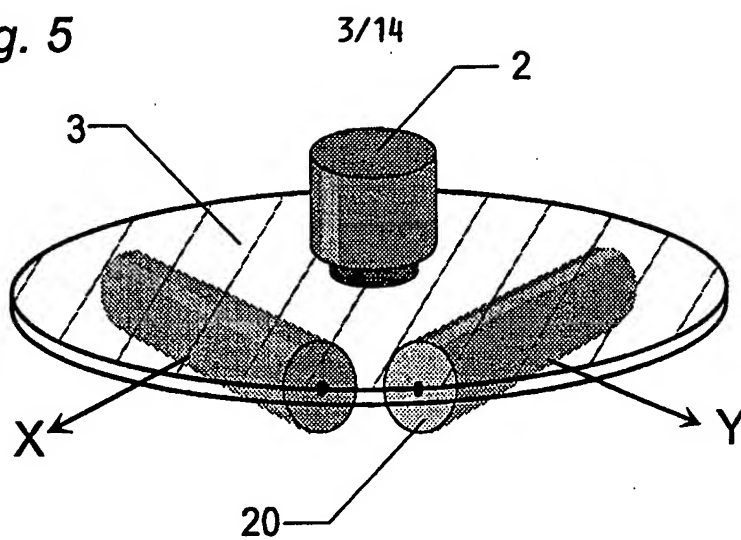


Fig. 6A

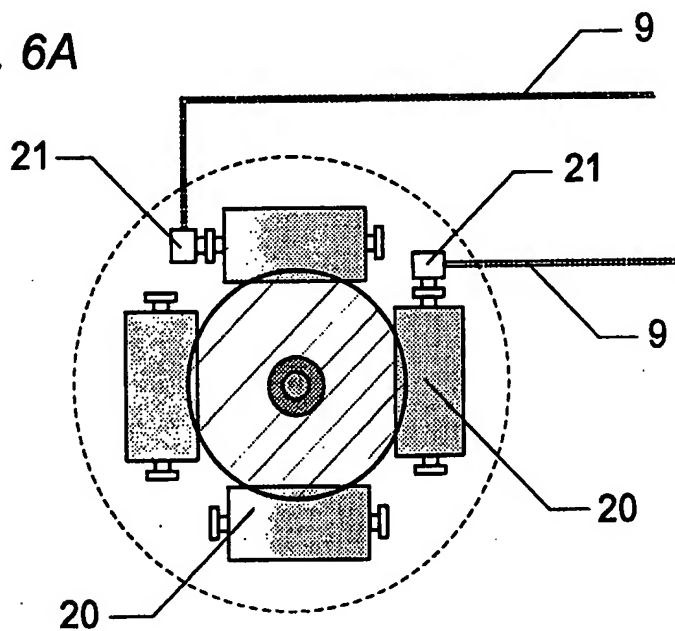
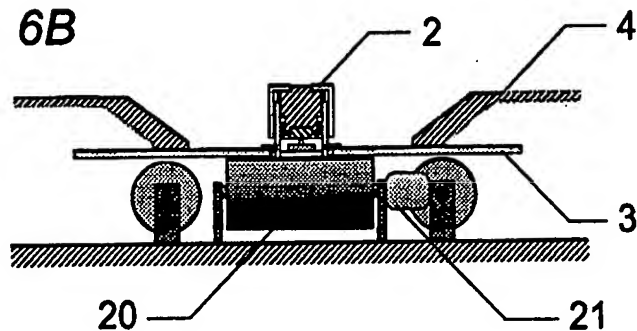


Fig. 6B



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Fig. 7A

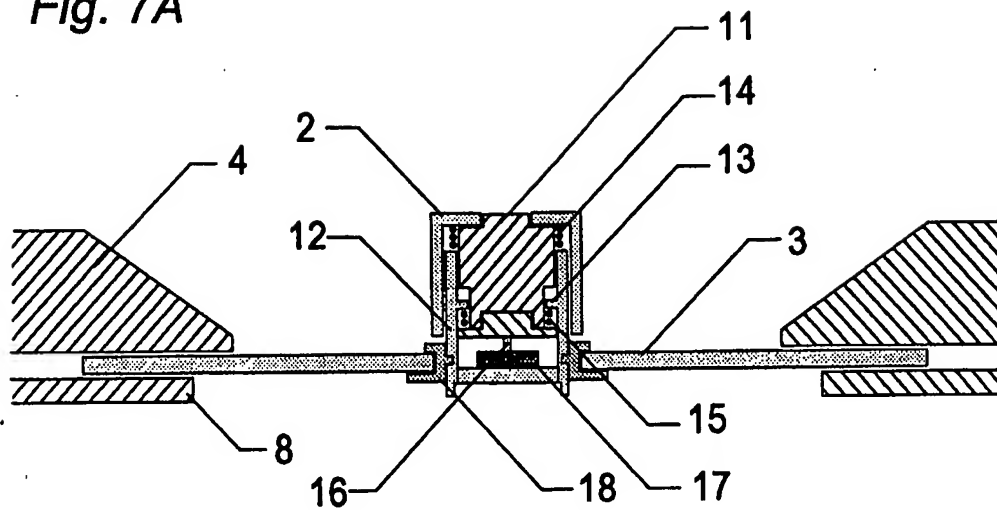
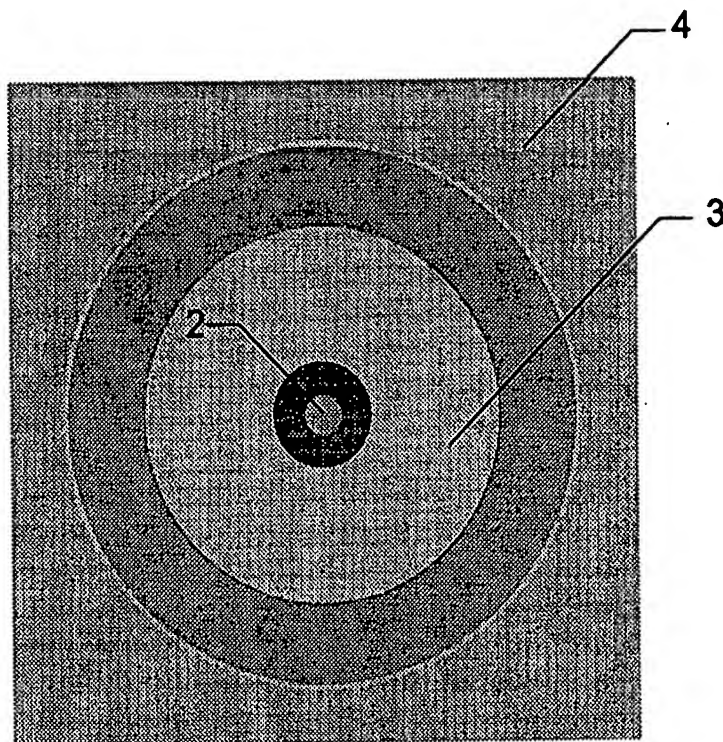
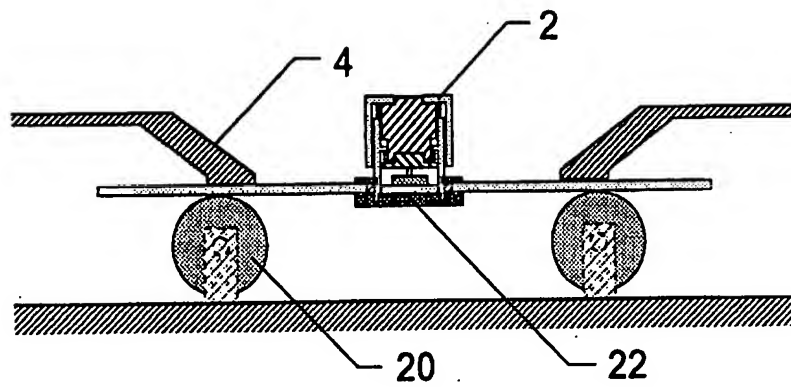
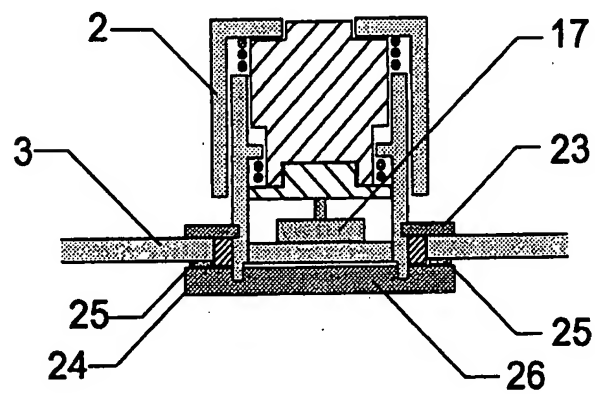
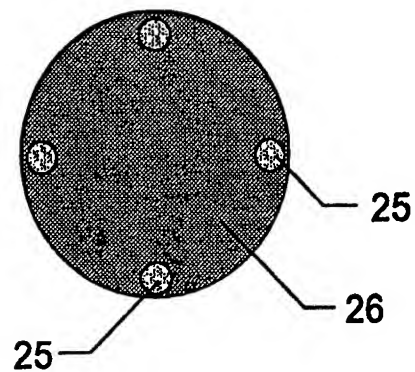


Fig. 7B



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Fig. 8*Fig. 9A**Fig. 9B*

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Fig. 10A

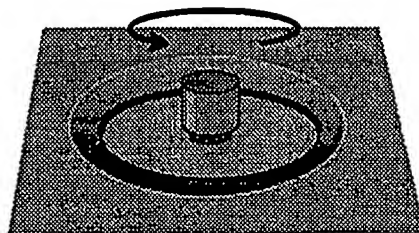


Fig. 10B

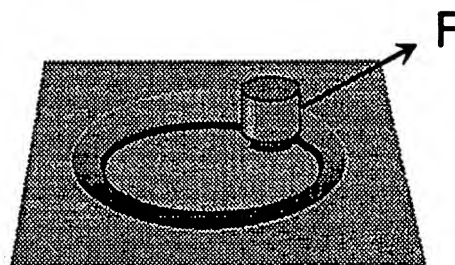


Fig. 10C

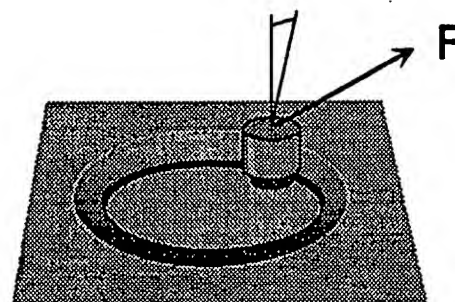
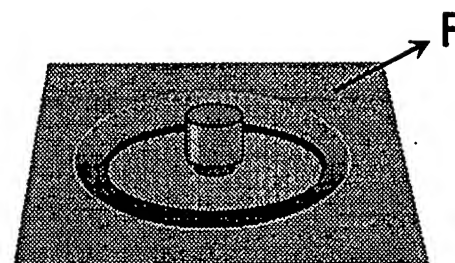


Fig. 10D



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Fig. 11A

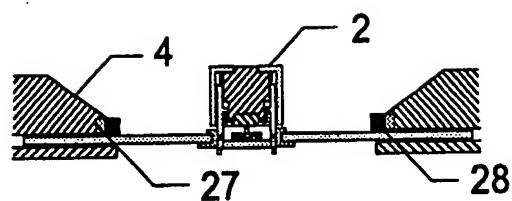


Fig. 11B

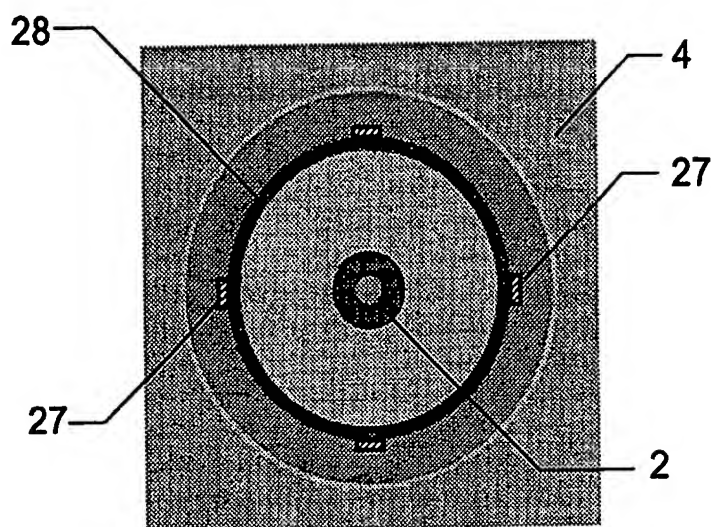


Fig. 12

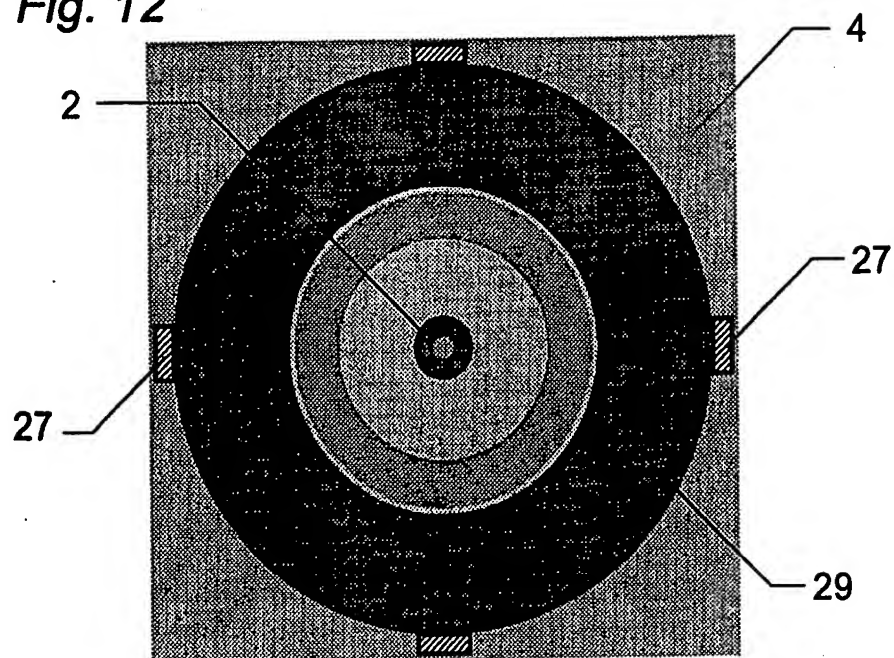


Fig. 13

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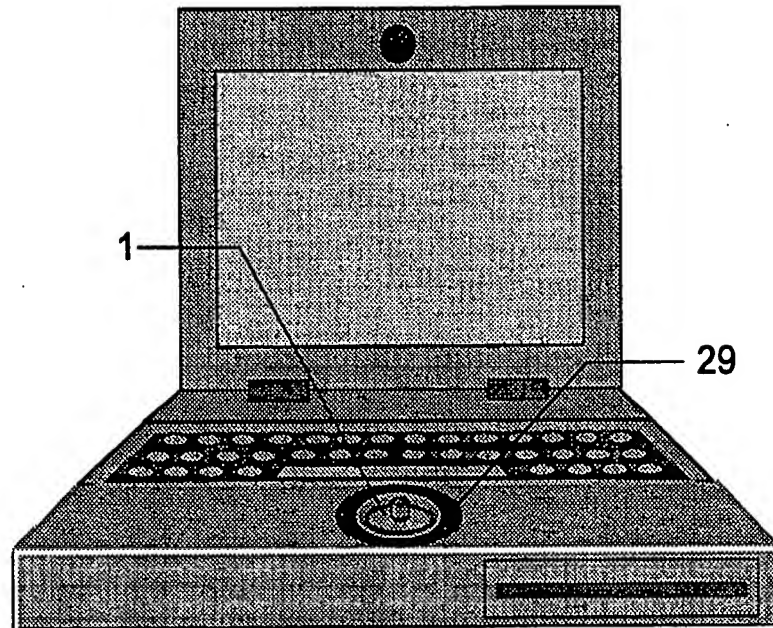


Fig. 14

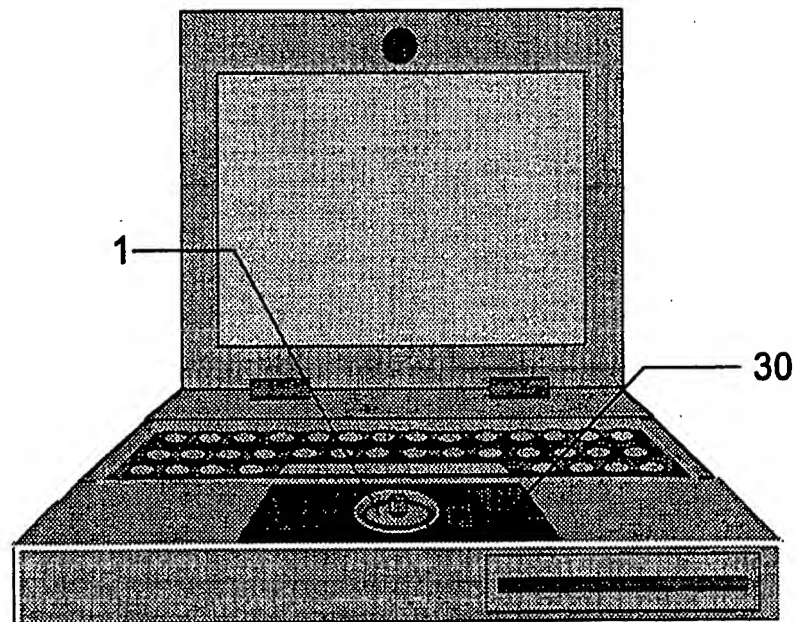


Fig. 15

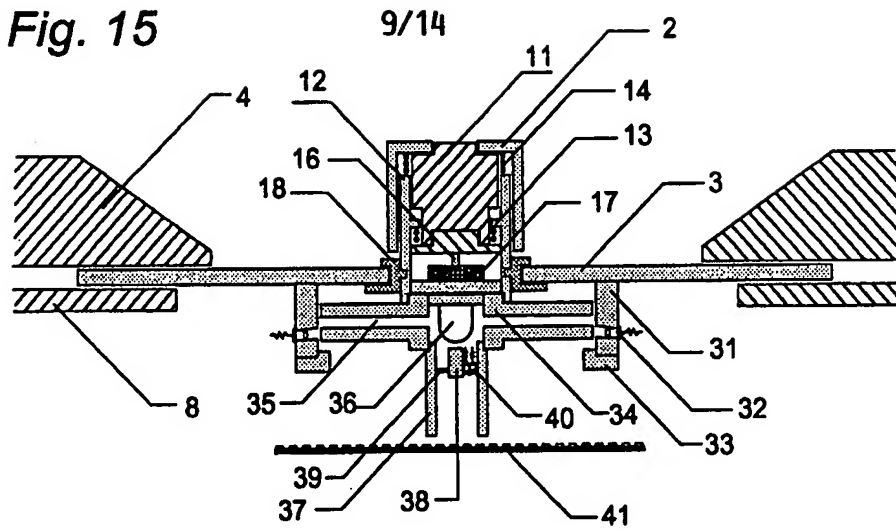


Fig. 16A

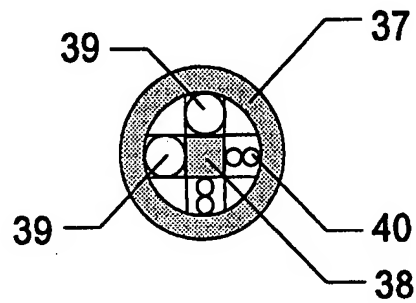


Fig. 16B

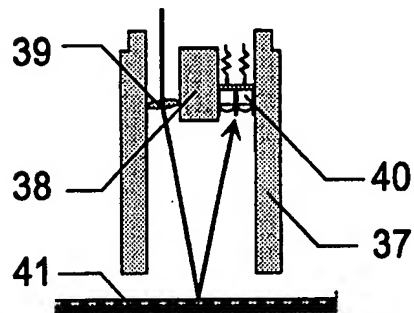
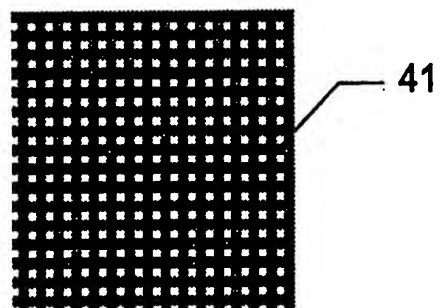


Fig. 16C



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Fig. 17A

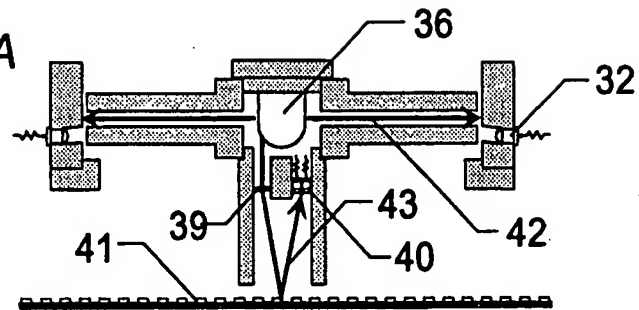


Fig. 17B

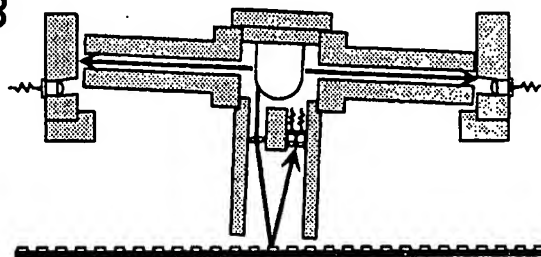


Fig. 17C

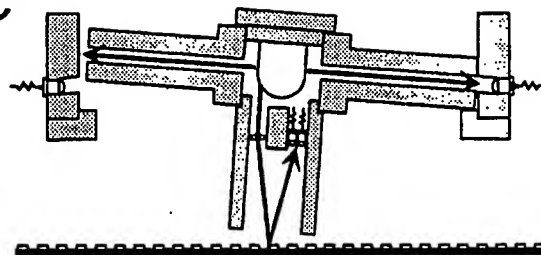
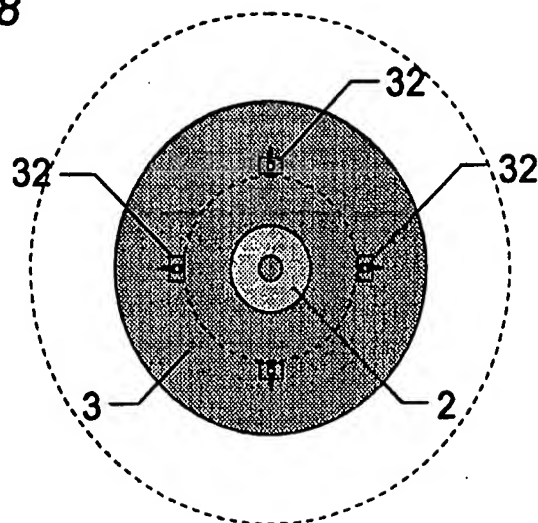


Fig. 18



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Fig. 19

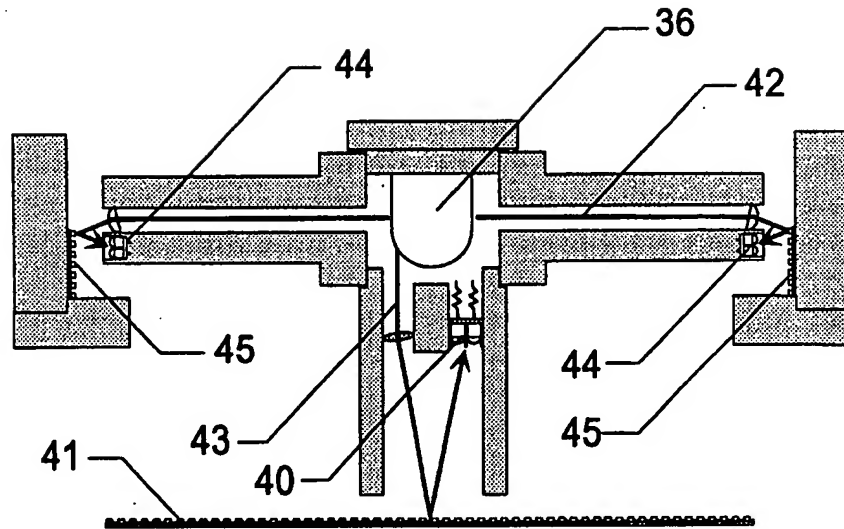
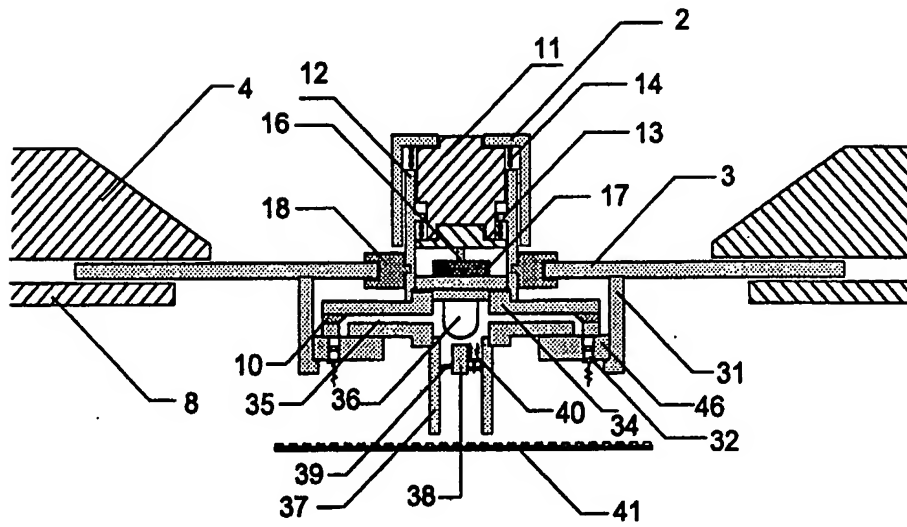


Fig. 20



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Fig. 21

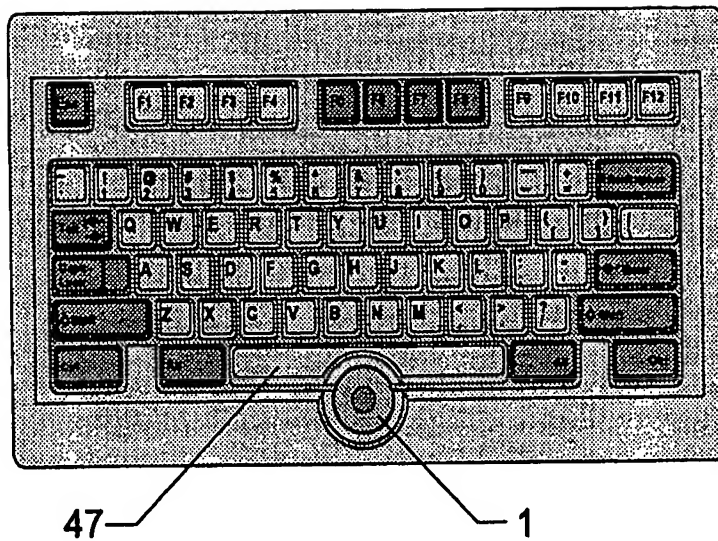
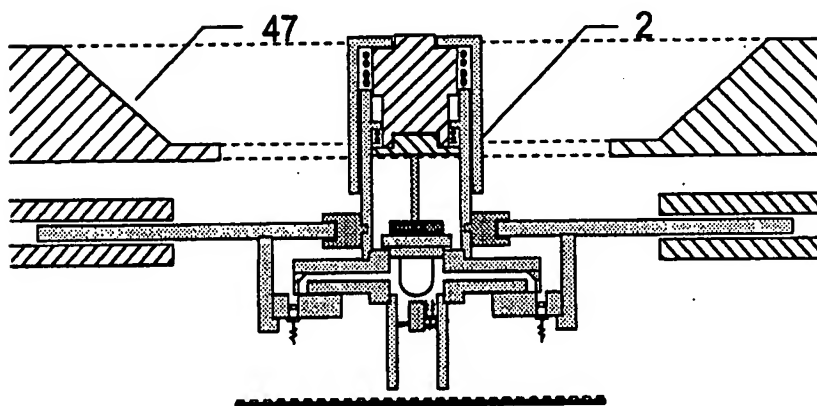


Fig. 22



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Fig. 23A

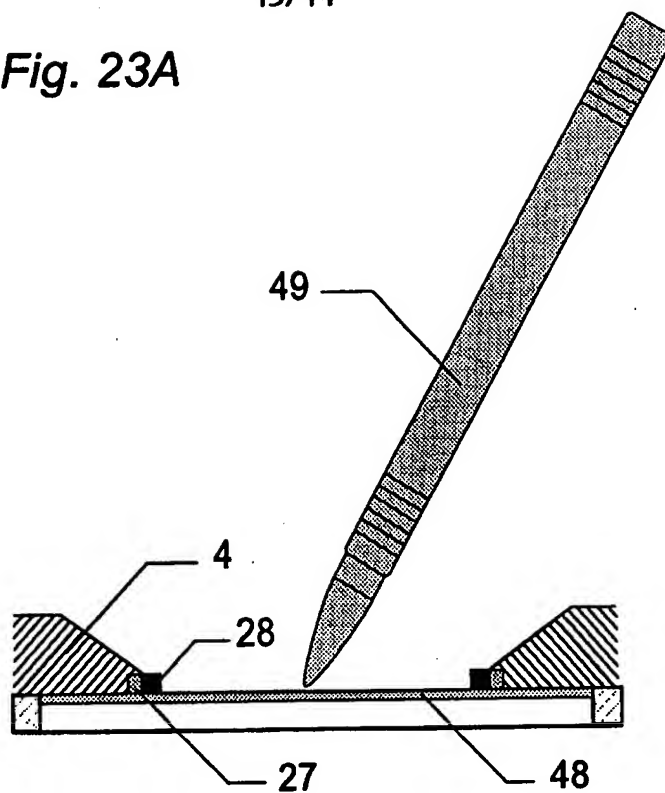
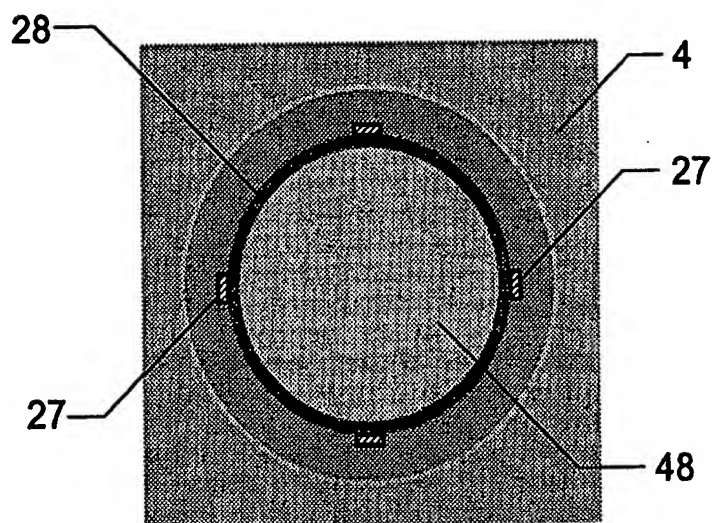
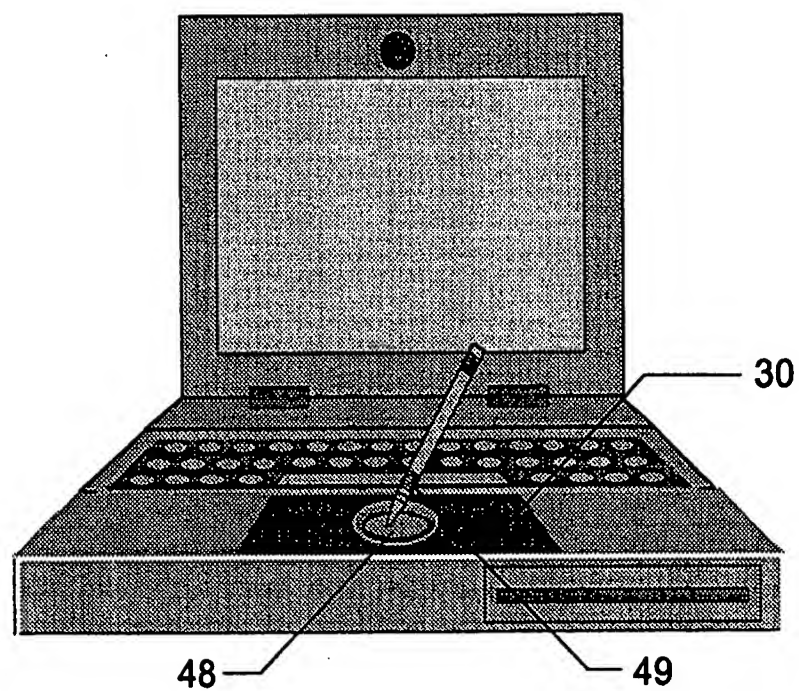


Fig. 23B



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Fig. 24



INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 94/00113

A. CLASSIFICATION OF SUBJECT MATTER

IPC : G06F 3/033, G06K 11/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC : G06K, G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, A1, 0539599 (FUJITSU LIMITED), 5 May 1993 (05.05.93), column 8, line 1 - column 11, line 30, figures 4A,4B,5	1-5,8,13-18, 25
Y	column 11, line 31 - line 39, figure 11	6,7,9-12,19, 22
A	--	20,21,23,24, 26,27
Y	US, A, 4719455 (WILLIAM M. LOUIS), 12 January 1988 (12.01.88)	6,7,9-12
	--	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

15 Sept. 1994

Date of mailing of the international search report

28 -09- 1994

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Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 94/00113

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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